PCB-Caulk Replacement Project Johnson Space Center Houston, TX

William M Young CIH, CSP, CSC-ATG
William K Molenda, CSC-ATG
Penney M Stanch, NASA-JSC

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Purpose

In June 2009 NASA's Johnson Space Center (JSC) started a project to re-caulk, clean, and seal the Precast Exposed Aggregate Faced (PEAF) Panels on buildings at the center.

- NASA JSC in Houston, TX has over 130 buildings on an 1,620 acre campus.
  - Buildings in Mall area (built in 1960s) are primarily covered with PEAF Panels with caulk expansion joints between panels.
  - PEAF panels were high-pressure washed many times over the years.
  - Caulk between panels had been replaced in sections.
  - Gaps between PEAF Panels ranged from 1/8-inch to 1 inch wide.
  - Many buildings had developed leaks in caulking after Hurricane Ike hit the Center in September 2008.

Background

- In Sep 2009, EPA advisory identified polychlorinated biphenyl (PCB)-containing caulks as hazardous & provided guidance for removal; suggested work should avoid skin contact & keep surfaces wet to reduce dusts.
  - PCBs are persistent in the environment *
- No MSDSs for caulk used (present or past) at the facility were found to have PCBs listed in the ingredients & composition section.
- Two caulks in stock for repairs were tested for PCBs with negative (ND) results.

* http://www.epa.gov/pcbsincaulk/caulkexposure.htm

Background

- Twenty random caulking samples from 7 building exteriors had PCB concentrations ranging from (none detected) ND to 60,521 mg/kg (ppm) when analyzed for 7 common PCB congeners.
  - PCB-1254, n=9 None Detected (ND) to 60,521 mg/kg (or ~6.05% PCB-1254)
    - IUPAC Name: 1,2,3-Trichloro-4-(2,3-dichlorophenyl)benzene
  - PCB-1248: n=6 ND (<2.5mg/kg) to 4,165 mg/kg PCB-1248.
  - Five samples had no PCBs detected.
  - The average PCB concentration n=20 was 7,884 mg/kg.
- No detailed records of past maintenance or caulk replacement were available.

PCB OELs

Substance	ACGIH TLV (mg/m^3)	OSHA PEL (mg/m^3)	NIOSH REL (mg/m^3)
PCB-1242 Chlorodiphenyl (42% Cl)	1.0 S	1.0 S	0.001*
PCB-1254 Chlorodiphenyl (54% Cl)	0.5 S	0.5 S	0.001*

* Appendix A: NIOSH REL established "for most carcinogens were non-quantitative values labeled lowest feasible concentration (LFC)"

S – Skin Notation

Other OELs in this Study

Substance	ACGIH TLV (mg/m^3)	OSHA PEL (mg/m^3)	NIOSH REL (mg/m^3)
Total PNOC/PNOS	10	15	NE
PNOS-R	3	5	NE
Si- Quartz-R	0.025	10/% SiO_2+2	NE
Si-Cristobalite-R	0.025	(1/2)(10/% SiO_2+2)	NE

PNOC/PNOS – Particulates Not Otherwise Classified or Specified
Si – silica R – Respirable NE – Not Established

Work Plan

In March 2010, JSC began the renovation project.

- All caulk was to be treated as PCB-contaminated.
- Cover ground below work with plastic to be rolled up for disposal daily.
- Used PPE is to be bagged for PCB disposal
- Use manlifts to raise workers along PEAF Panels to remove caulk
- Replacement caulk required that surface edges be roughened up with a grinder, then have a primer painted on, prior to injecting the new caulk to retain the warranty.
- 2 Contractors, 2 Procedures:
  - *Wet Procedure*
  - *Dry Procedure*

Procedure & Exposures

- Initially remove as much existing caulk as possible with reciprocating blade or utility knife wearing full-face respirator and coveralls
  - PCB (Skin contact)

- Grind PEAF Panel to provide abraded cleaned surface for new caulk. Grinders equipped with HEPA vacs
  - PCB (Skin and Inhalation)
  - Other (PNOC/PNOS) dusts
  - Silica (Si) Dust
- Insert backing rod
- Apply primer
- Apply new caulk

Sampling Plan

- Work plan to evaluate
  - Wet methods vs. dry methods,
  - Caulk removal blades (serrated vs. smooth),
  - Grinder blades, etc.
- Collect personal air monitoring for:
  - PNOC, PNOC-R, Silica-R, Grinder Dusts Bag Bulk–PCB, PCB vapors and dust
  - Evaluate PPE requirements

Wet Method

- Use experienced asbestos workers.
- Don PPE – Saranex-Coated Tyvek suit, initially FF Respirator w/P100 cartridges; after initial monitoring - Faceshield and side-shield safety glasses
- Use a mini-enclosure during grinding
- Wet the area
- Use reciprocating saw or utility knife to slice both sides of caulk
- Pull bulk caulk and put in containment
- Continuously wet the surface
- Use grinder to prepare surface
- Prime & apply caulk next day
- Air Monitoring
  - Personal PNOC & PNOC-R
  - Silica-R

Wet Method Personal Air Sample Results

	N	Range (mg/m^3)	Average (mg/m^3)
PNOC-R	14	ND(<0.008)-0.48	<0.08
PNOC	32	ND(<0.01)–5.23	<0.84
Silica-R	20	ND(<0.007)–0.016	<0.011

Note: Results are for the time monitored, not adjusted for shifts.

- Evaluation for PCB exposure assumed worst case exposure by using highest concentration from bulk samples taken prior to project start (6.05% of PCB-1254), calculating 95th percentile of samples taken (9.13%), then applying it to maximum PNOC measured:

  0.09 13 x 5.23 mg/m^3 = 0.48 mg/m^3 < TLV and PEL

- Therefore, estimated PCB exposure below the TLV & PEL

Wet Method Changes/Learning

- Workers using wet methods were allowed to downgrade from full-face respirators to no respirators and face-shield PPE
- Saranex-Coated Tyvek coveralls were replaced with sleeved smocks to reduce heat stress
- Serrated blades were evaluated to eliminate grinding the surface with a disc grinder. The blades did not abrade the surface enough so smooth blades were used on the reciprocating saw to reduce dust.

Dry Method

- Use professional building waterproofers
- Don PPE – Tyvek suit, FF Respirator w/P100/OV cartridges
- Use reciprocating saw or utility knife to slice both sides of caulk
- Pull bulk caulk and put in containment
- Use grinder to prepare surface
  - Shroud & vacuum to minimize dust emission
- Apply primer & caulk on same day
- IH Air Monitoring Plan
  - Personal monitoring for PCB vapors and dusts
  - Personal & area monitoring for Silica-R
  - Personal & area monitoring for PNOC & PNOC-R (some in manlift)

Dry Method
Personal Air Sample Results

		N	Range** (mg/m^3)	Average** (mg/m^3)
PCB-1248	ASTM D4861	5	0.0037 - 0.058	0.0165
PCB-1254	ASTM D4861	1	0.038	0.038
7 Congeners *	NIOSH 5503	6	All ND <0.0196 - <0.0685	<0.0352

* PCB-1260, 1254, 1221, 1248, 1232, 1016 &1242: all below reporting limit
** Results are for the time monitored, not adjusted for shifts

	N	Range** (mg/m^3)	Average** (mg/m^3)
PNOC-R	3	<0.01 -0.22	<0.17
Cristobalite-R	3	<0.01 (ND)	<0.01
Quartz-R	3	<0.01-0.054	<0.033

Dry Methods Change/Learning

- Had caulk-removal workers remain wearing Full-Face Respirators with P-100/OV cartridges and faceshields for grinding due to silica monitoring results
- Changed from Tyvek coveralls to two layers of long-sleeved work clothes to reduce heat stress, to be laundered or disposed of in waste
- Barrier monitoring resulted in concentrations ranging from well below exposure guidelines to non-detect for particulates, silica, & PCB

Summary

- Wet method reduced exposure by minimizing overall respirable particulate release. Dry method didn't introduce delays for primer/caulk application.
- Removed caulks came in many forms, from dry powdery to tarry sticky. Varying textures were not sampled or packaged differently.
- During the course of the project, EPA modified recommended practices to include full containment for exterior caulk removal. Changes are ongoing. Initial recommendations were directed to school buildings. EPA is researching risks due to caulk.
- Exposure guidance lacking except for 2 of 209 PCB congeners
- Work was safely completed on schedule and under budget.

Questions?

What are PCBs?

Polychlorinated biphenyl (PCB) compounds were identified as carcinogens in the 1980's.

- Studies found liquids, commonly used in electrical transformers, contained harmful amounts of PCB.
- There are over 209 congeners of PCB identified primarily by the percent chlorine (% Cl) in the compound.
  - 7 congeners are typically identified for environmental impact,
  - 2 congeners have PELs and TLVs
- Studies in workers exposed to PCB-containing liquids have shown indications of:
  - liver damage; skin & eye lesions; irregular menstrual cycles; lowered immune defense systems; headaches, fatigue, coughing, unusual skin sores; risk of cancer; in children, poor cognitive development.

What are PCBs?

Studies in workers exposed to PCB-containing liquids have shown indications of:

- liver damage through changes in blood and urine.
- skin and eye lesions,
- irregular menstrual cycles, and
- lowered immune defense systems.
- headaches, fatigue, coughing, unusual skin sores.
- a risk of cancer and,
- in children, there were reports of poor cognitive development.

PCBs are persistent in the environment and occurred in caulks.

PCB Environmental Guidelines

- Seven congeners are typically identified for environmental impact, PCB-1016 (10 carbon atoms & 16% chlorine), 1221 (12 carbon atoms & 21% chlorine), 1232 (32% chlorine), 1242 (42% chlorine), 1248 (48% chlorine), 1254 (54% chlorine), and 1260 (60% chlorine). http://www.epa.gov/pcbsincaulk/
- Caulks with over 50 ppm PCB (of the 7 congeners) must be removed and are to be treated as Bulk Product Waste
- Contaminated soil and materials near buildings are to be treated as PCB Remediation Waste
- Other countries have Regs for other congeners

Dry Method Caulk Removal Area Air Sample Results

	N	Range (mg/m^3)	Average (mg/m^3)
PNOC	20	ND(<0.01)-0.43	<0.065
PNOC-R	12	ND(<0.01)-0.03	<0.015
Cristobalite-R	12	All ND(<0.01)	ND(<0.01)
Quartz-R	12	All ND(<0.01)	ND(<0.01)
PCB – 7 congeners ASTM D4861	12	ND(<0.0001) – 0.0096	< 0.0019
PCB – 7 congeners NIOSH 5503	4	<0.0199-<0.0250	<0.0218

PNOC – Particulates Not Otherwise Classified R – Respirable
ND – none detected at a limit of detection

Bulk Vacuum Shrouded Grinder Bag Results

Bldg	N	PCB-1248 Range	PCB-1248 (avg-PPM)	PCB-1254 Range	PCB-1254 (avg-PPM)
A	3	47.8-89.2	64.7	ND	ND
B	1	2,420	2,420	ND	ND
C	2	ND	ND	1,504-4,985	3,245

ND – None Detected for 1016, 1221, 1232, 1242, 1260